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ABSTRACT

A scheme which classifies the instructional applications of computers is designed to overcome the confusion created by the imprecision and equivocation associated with computer terminology. The classification is restricted to instructional applications, allows that some applications could apply to more than one category, and reflects a continuum of applications from simple to complex. Five major types of applications are postulated--laboratory tools, teaching support systems, teaching systems, learning systems, and tools for research. Laboratory tools include calculators and compilers. Teaching support systems aid the management of teaching and cover 1) teacher-oriented applications such as data banks, answer processors, statistical packages and test generators and 2) the student-oriented applications of individual testing and computer-managed instruction. Teaching systems are those in which the computer is the main support of information; drill and practice and computer-assisted tutorials are the major applications found under this rubric. Simulations and inquiry dialogues are subsumed under learning systems, while in the final category, research tools, are activities such as course and test validation and the development of learning models. (PB)

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CLASSIFICATION OF THE USES OF COMPUTERS IN EDUCATION

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DU QUEBEC

AOUT 1972

EM 011 477

FOREWORD

This paper was prepared for the ADIS conference of August 1972 in Quebec City.

It is based on the work of a group of people at the "Laboratoire de Pédagogie Informatique", and on a paper written by Jean-Marie Morin*.

The author of the present text revised, completed and translated the first version of the classification presented in Mr. Morin's paper.

* MORIN, Jean-Marie,
"CLASSIFICATION DES UTILISATIONS DE L'ORDINATEUR POUR DES FINS PEDAGOGIQUES"
LPI, Service de l'Informatique du ministère de l'Education, Mai 1972, 11p.

CLASSIFICATION OF THE USES OF COMPUTERS IN EDUCATION

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INTRODUCTION:

Two of the goals of the "Laboratoire de Pédagogie Informatique" are experimentation and the spreading of information about the use of computers in education.

In the course of our activities, we often had in the past years, to meet people, talk with them about their instructional problems, and try to explain the help the computer could provide to solve these problems. We also had to write reports on the nature and feasibility of the application of the computer to education.

Very soon, one finds that the vocabulary in use in this new field of technology, is very different from one author to another, from one research center to another, and that, it is not altogether coherent. C.A.I., for example, can be used to characterize the whole field of computer applications to instruction. On the other hand, its principal use is in opposition to C.M.I., referring to an instructional system in which the whole teaching situation is computer-controlled.

Figures 2, 3 and 4 present three of the classifications or listing of instructional logic in use presently. These examples were choosen at random.

Over the years, we devised our own classification, which is shown in Figure II of this document (page 22). In studying this classification, one has to keep in mind that:

A- the classification refers to the different uses of computers in the instructional field. That deals out any use of the computer as a tool in the administration of the educational system (e.g. payroll, allocation of material ressources, etc...). Our concern here is with instruction.

B- this is not a taxonomy but a classification. Although we believe that most of the applications of the computer in education can be classified in at least one of the categories, it is possible that some applications could apply to more than one category.

C- in working out the classification, we tried to reflect a continuum, from simple (educationaly, technologically and economically) to more complex forms of applications. In every case, applications at a less complex level would help the implementation of applications at a more complex level.

D- finaly, the problem of terminology still exists, although our aim was to eliminate it. In this paper, the problem has two sources. First, the present classification is a translation. Secondly, even in its french form (in many cases), the definitions of the different applications were clearer than the terms used to express them. This is partly due to the fact of the fast expansion of the field. It is still hard to determine clear borders between each type of the applications.

SELTZER'S CLASSIFICATION

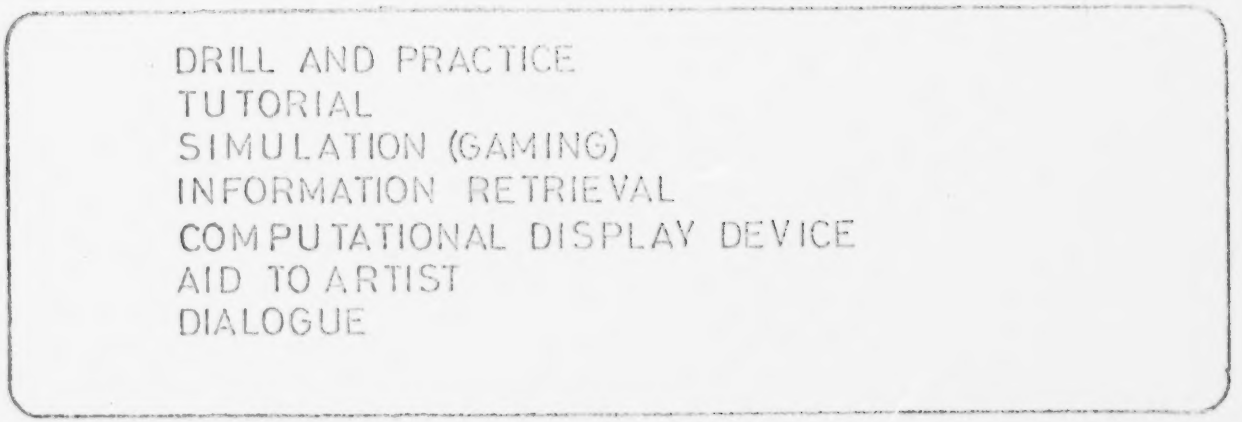


FIGURE 2

(See reference No 7 page 23)

LISTING OF COURSE LOGIC BY HELEN A. LEKAN

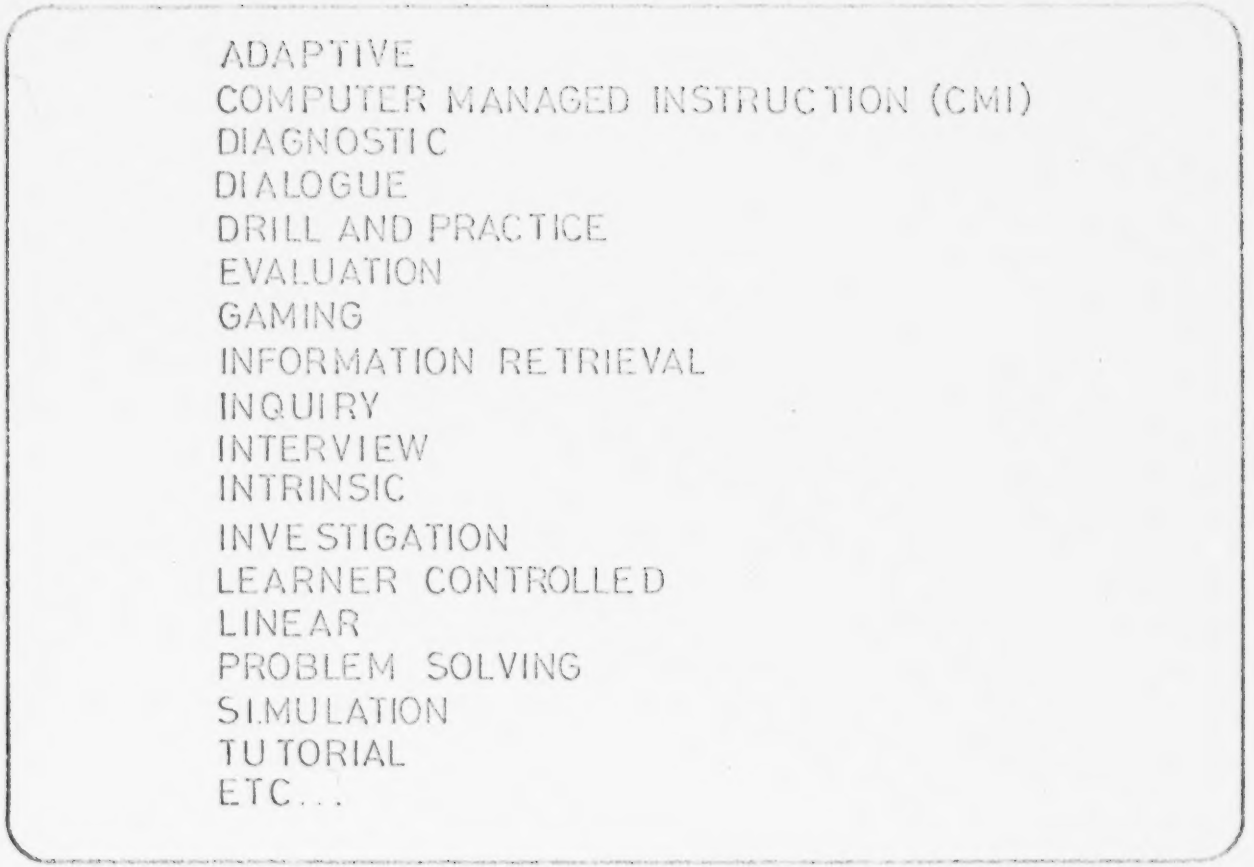


FIGURE 3

(See reference No 5 page 23)

ENTELEK'S CLASSIFICATION

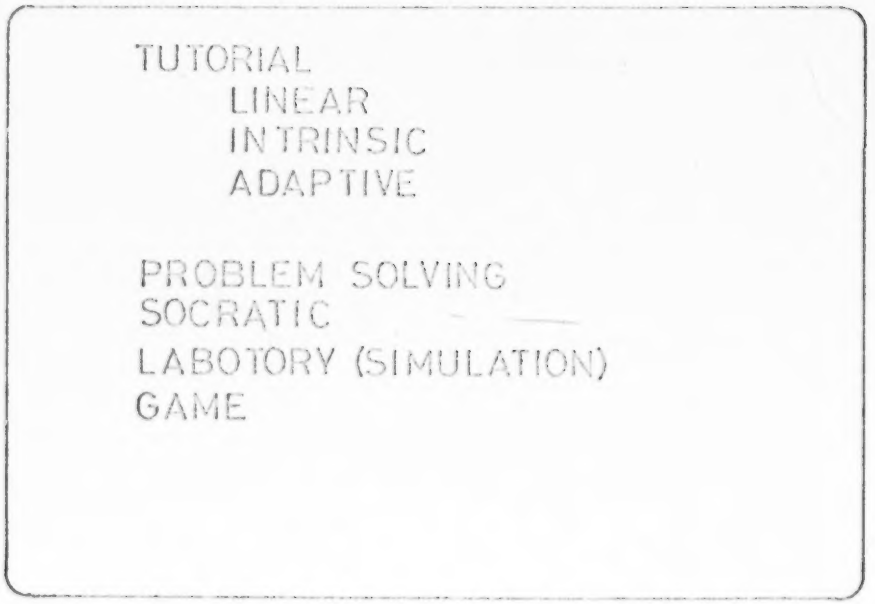


FIGURE 4

(See reference No 3 page 23)

1. LABORATORY TOOL.

A- Description.

This type of application occurs when the student can use the computer directly, with as little guidance as possible. The LABORATORY aspect of the use stems from the fact that the student experiences the possibilities and limits of the computer itself, or uses it to help himself experiment. This type of use can take two different forms:

B- Types.

1.1 CALCULATOR. In this mode the teacher provides the student with programs than can help him compute the results of an experiment he is conducting (for example, in physics, chemistry, aerodynamics, etc...). Such programs can take a conversational form as in some experiments conducted with the ITF system* at SIMEQ, or a batch form. See Figure 6 for an example, page 8.

1.2 COMPILER. In this type of use, the student is learning how to program a computer. He is working with a conversational system. By trial and error, with the help of a document and the system itself, he can learn a language and use it for his personal needs. This type of utilization can aim at teaching a particular language (PL/1, APL, FORTRAN, BASIC, etc...), but it has been put to use in teaching logic, geometry, mathematics, etc... See Figure 7 for an example, page 9.

* ITF:PL/1, IBM System/360 ØS/DØS, Introduction, IBM SC28-6833-1.

C- Equipment.

The use of a computer as a LABORATORY TOOL is one of the simplest. The only requirements of the application are the basic components of any data processing installation. That is, a computer, a terminal (either a card reader and a printer, or a teletype terminal), and the associated software. In the CALCULATOR mode, the teacher will have a few programs to write or adapt. In the COMPILER mode, the student is completely on his own when linked to the computer.

Experiments on this type of use conducted under ITF (as pointed out earlier) have shown how easily teachers and students can adapt to this type of utilization of the computer.

VOICI UN PROGRAMME QUI VOUS AIDERA A FAIRE
UNE ETUDE COMPARATIVE ENTRE DEUX GROUPES

ENTREZ LE NOMBRE DE SUJETS DANS CHAQUE CLASSE
PUIS LES SEPARANT PAR UNE VIRGULE,
EN APPUYANT SUR LA TOUCHE [RETURN].

? 10,12 ——→ Student's DATA

{ instructions on how to use the program

ENTREZ VOS RESULTATS DU PREMIER GROUPE
EN LES SEPARANT PAR UNE VIRGULE
ET APPUYEZ SUR LA TOUCHE [RETURN].
?
35,90,84,73,21,99,75,74,63,68 → Student's DATA

FAITES DE MEME POUR LE SECOND GROUPE

? 12,67,68,48,98,96,90,34,60,66,75,35 → Student's DATA

VOICI VOS RESULTATS MONSIEUR CHEVALIER

LA MOYENNE DU PREMIER GROUPE EST: 6.82000E+01

LA MOYENNE DU SECOND GROUPE EST: 6.24167E+01

SIGMA= 2.53244E+01

SIGMA M= 1.00433E+01

LA VALEUR DE T EST: 5.33350E-01

AUCUNE DIFFERENCE SIGNIFICATIVE

{ Results after computation

CE FUT UN PLAISIR DE TRAVAILLER POUR VOUS
REVENEZ NOUS VOIR BIENTOT...
EDIT

FIGURE 6

(See reference No 6 page 23)

EXAMPLE OF A "COMPILER" TYPE OF APPLICATION

```
00010 dcl aaa entry, a char(10), b(2,3)
00020 dcl rep(10)
00030 put list ('this program is a fake)
0256        INV STR
00030 ?
0256        INVALID SYNTAX FOR USE OF CHARACTER STRING
00030 put list ('this program is a fake')
00040 put list ('write your name')
00050 get edit(a)(a(10)
0252        UNBAL PAREN
00050 ?
0252        NUMBER OF ( DOES NOT EQUAL NUMBER OF )
00050 get edit (a)(a(10))
00060 put edit('welcome mr.'a)(a(11),a(
                                    x(3),a(10))
0209        DELIM MSNG
00060 ?
0209        2 CONSECUTIVE VARIABLES OR CONSTANTS IN STATEMENT
00060 put edit('welcome mr.',a)(a(11),x(3),a(10))
00070
EDIT  run ---> EXECUTION
```

```
THIS PROGRAM IS A FAKE
WRITE YOUR NAME
?     joe blow
WELCOME MR.    JOE BLOW
EDIT
```

FIGURE 7

2. TEACHING SUPPORT SYSTEMS

A- Description.

We include in this type of application all systems that come to the aid either to the teacher or the student in the management of the different steps of their tasks.

The computer doesn't teach or present instructional material to the student. It stores in its memory information that can help the teacher; computes results of tests and statistical analysis; keeps track of the student's path through a course, etc... In other words, it can accomplish a number of jobs to improve the teaching or learning performances.

2.1 TEACHER ORIENTED SUPPORT SYSTEMS

A- Description.

A teacher in performing his tasks has a lot of jobs to do, like defining educational objectives, writing questionnaries for tests or exercises, correcting tests, computing their results, and also looking for different instructional material etc... The present use of the computer aims at reducing the efforts of the teacher in performing these time consuming jobs. We can discern different types of applications such as:

B- Types.

2.1.1 DATA BANK. These systemps work on the principles of the information retrieval systems. The data kept in the banks are of an instructional nature. We could imagine that banks of objectives could be available to the teacher on different topics to help him determinate particular objectives for a course. Or the teacher could have access to a bank of questions, like in CTSS*, which is in use in the school district of Los Angeles. We could also think of a bank of references associated to particular instructional material.

2.1.2 ANSWER PROCESSOR. Correcting tests is time-consuming for the teacher. Programs exist to do this, although most of the tests that can be processed are of the multiple choice variety. Figure 8 gives a list of the different types of answers that can be used in a test.

Although the closed answers are easier to process, it is doubtful that they are sufficient to test all types of learning.

2.1.3 STATISTICAL PACKAGE. This type of application is well known. A great number of programs exist that process either raw or already corrected answers and produce at the output statistical tables and diagrams. CTSS, already mentionned, is an example of this type of utilization.

* See reference No 2 page 23.

DIFFERENT TYPE OF ANSWERS

A____ CLOSED ANSWERS

- MULTIPLE CHOICE
- TRUE OR FALSE

B_____OPEN ANSWERS

- DIGITAL
- ALGEBRIC OR MATHEMATIC EXPRESSION
- WORDS AND SENTENCES

FIGURE 8

2.1.4 TEST GENERATOR. Unlike the use of computer in processing a question bank (defined in 'DATA BANK'), the present use of the computer makes it possible to generate test questionaries on precise specifications. For example, at l'Ecole Polytechnique in Montreal, people at the data processing center devised a program that generates up to thirty different tests on a given subject-matter, each of which measure the same set of objectives, the results of which being comparable.

C- Equipment.

In most cases, applications of the computer in the TEACHER ORIENTED SUPPORT SYSTEM is done in batch processing. The terminals used are card readers and fast printers. It is easy to forecast though, with the increasing use and facilities of the different conversational systems, that many such applications will be available through these systems.

The advantages would be, low response time, and easy debugging and modification of the programs according to the needs of the moment. On the other hand, many aspects of these utilizations would make it more convinient and economic to use fast printer and batch processing.

This type of application of the computer introduces the need of more defined criteria for the classification of instructional material, and the use of educational tools such as instructional objectives.

2.2 STUDENT ORIENTED SUPPORT SYSTEMS

A- Description.

This type application of the computer directly aims at individualizing instruction. In its simplest form it is an extention of the TEACHER SUPPORT SYSTEMS with an emphasis on individual performance and abilities. In its more complex form it is a completely individualized and computer managed system of instruction. Here we defined two types of particular uses.

B- Types.

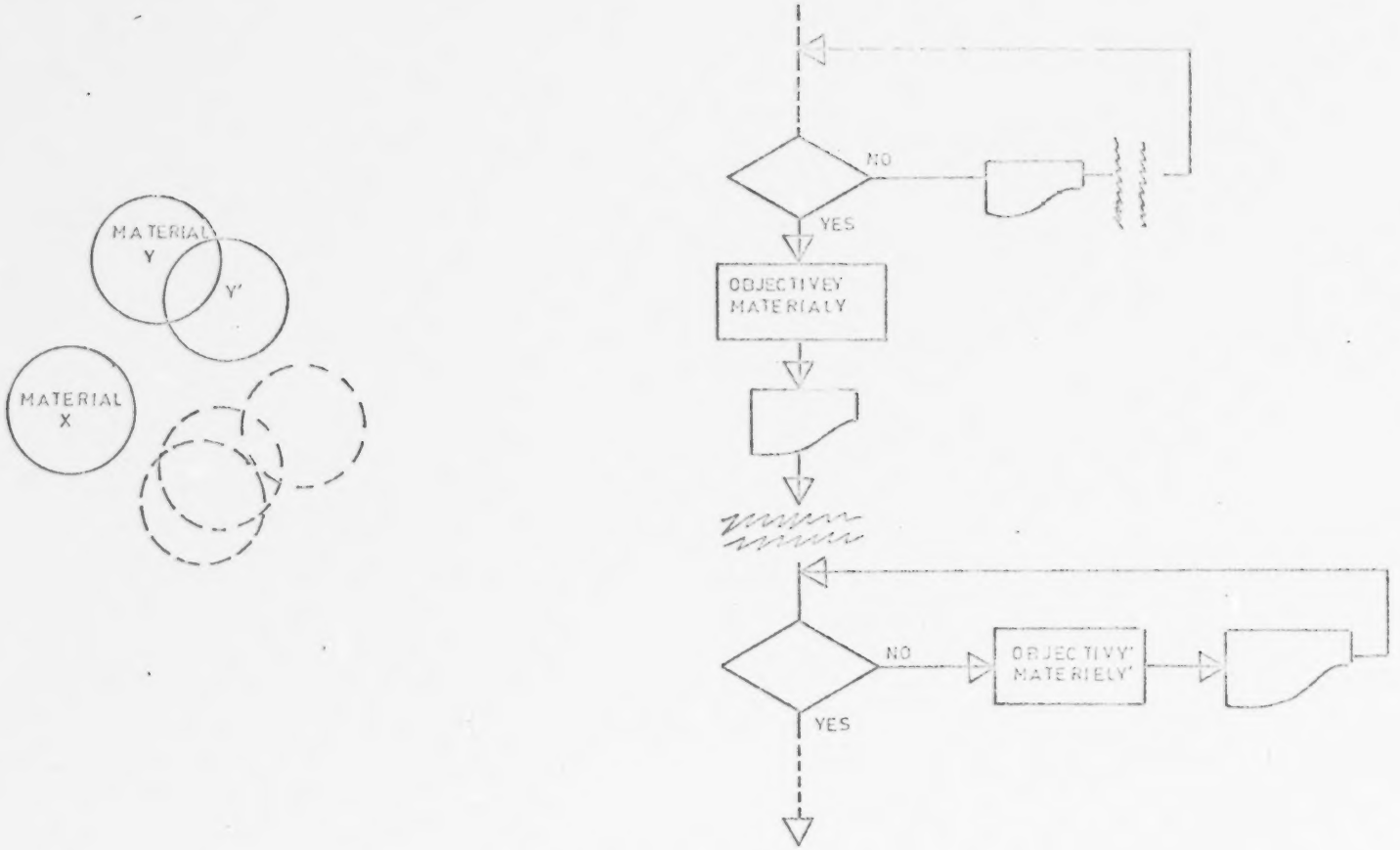
2.2.1 INDIVIDUAL TESTING. This term applies to a type of test generation based on the individual abilities and performances. It supposes that the computer has the possibility to keep track of the student past performances. The test is generated for a particular student according to the objectives he is aiming for at the moment. It can be a dynamic testing like in CAT* where the number of questions necessary to evaluate the student's performance for a set of objectives is a function of his performance in the test.

2.2.2 CMI. The computer managed instruction is a support system where the computer:

- keeps track of the student past performances,
- presents him with tests,
- helps him and his teacher, make the best possible decision regarding the course flow, in presenting him (or them) with suggested instructional activities according with the past performances of the student and the objectives he is aiming for.

* See reference No 1 page 22.

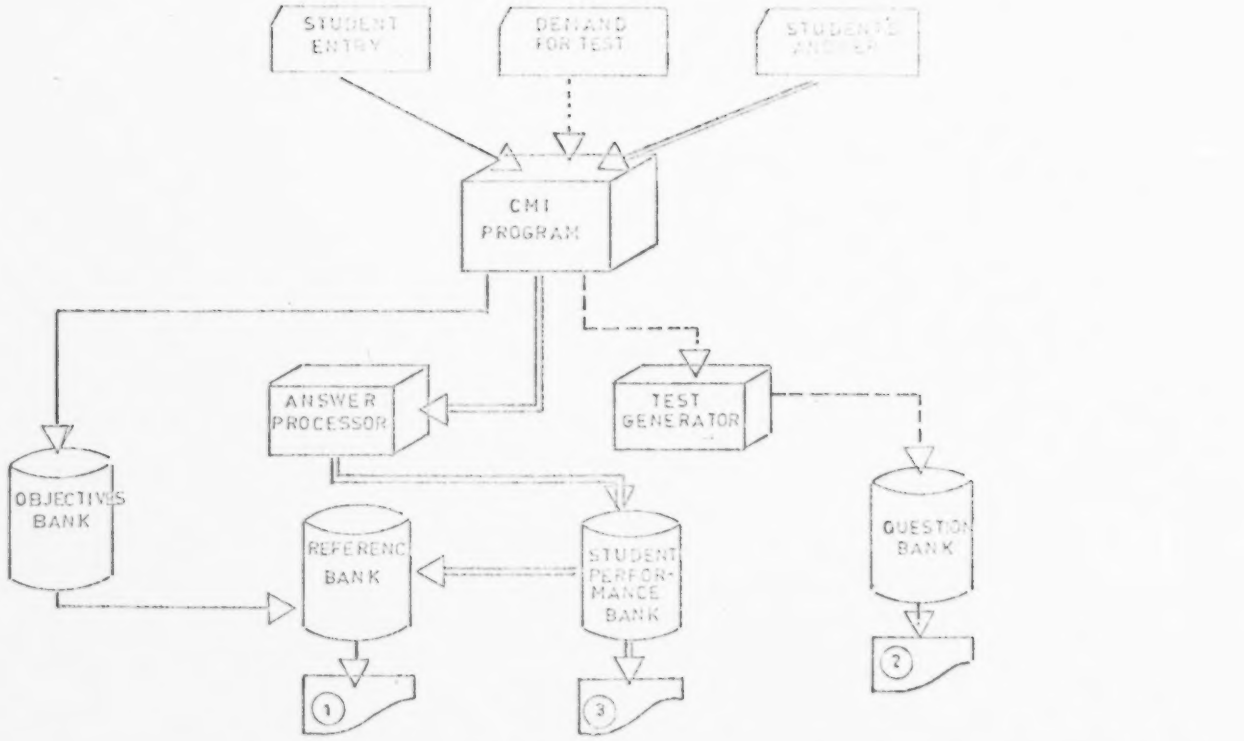
FIGURE 9



ON LINE CMI

SYMBOLS:

- OFF LINE WORK BY STUDENT
- TEST
- SELECTION OF OBJECTIVES AND MATERIAL
- PRINT OF | TEST RESULTS
  OBJECTIVES
  REFERENCES

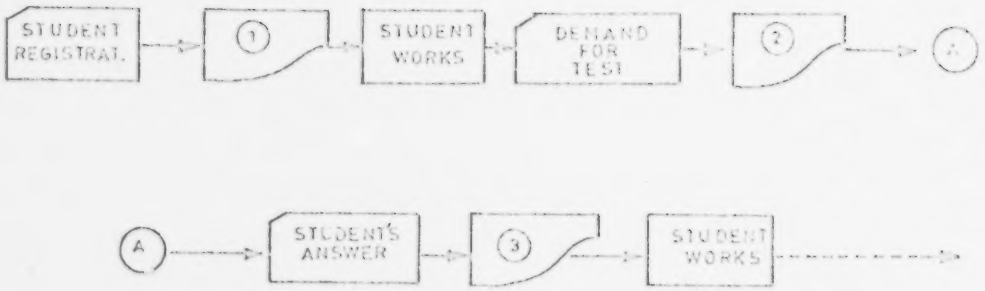


1 OBJECTIVES AND REFERENCES TO COURSE MATERIAL TO HELP THE STUDENT REACH THE OBJECTIVES

2 LIST OF QUESTIONS TESTING THE ATTAINEMENT OF THE SPECIFIC OBJECTIVES

3 LIST OF STUDENT PERFORMANCES

FIGURE 10A



OFF LINE CMI

FIGURE 10B

The computer does not present the student with instructional material. In most cases the student works with already existing material (audio-visual-printed and teacher courses). A good example of this type of application is the project PLAN. CMI can be more or less individualized. It can be applied with the student "ON LINE", interacting at an individual terminal or "OFF LINE" through optical or punch cards and printed reports. (See figures 9, 10 and 10A).

C- Equipment.

STUDENT ORIENTED TEACHING SUPPORT SYSTEMS call for the same hardware necessary for the TEACHER ORIENTED type of application.

As far as terminals are concerned they can be either fast or slow terminals depending on the particular situation. The software part of the application becomes increasingly important as the application gets more complex. One of the requirements is for an easy file processing software.

The courseware increases in complexity from one type of application to another. It asks for determining precise objectives, relating and classifying them logically, producing tests according to the objectives, looking for available instructional material (again in relation to the objectives), relating objectives, tests and instructional material, programming course flow, etc...

3. TEACHING SYSTEMS

A- Description

We group under this name some of the applications now labelled "Computer-Assisted Instruction" mainly those labelled tutorial of drill and practice.

In general, this type of utilization of the computer applies to all systems where the computer is the main support of the information delivered to the student. As in CMI, the computer tests the student and suggests to him instructional material.

On top of that it presents the student with the material itself. We can discern two main types of applications. Both types, drill and practice, and tutorial are very well known and hardly need an elaborate discussion.

B- Types

3.1 DRILL AND PRACTICE. This type of application refers to questions presented to the student in order to help him practice specified abilities (v.g. add number).

3.2 CAI TUTORIAL. In CAI-Tutorial the computer performs all of the tasks normally performed by the teacher.

It presents the information, asks questions to ascertain if the student understood, and directs the student through a course according to his past performances and abilities.

C- Equipment

Many systems (hardware and software) permit CAI tutorial, and drill and practice types of application. CAI asks for a conversational system and individual terminals (whether it's a teletype, a cathode ray tube or a plasma display panel).

The courseware is very sophisticated. It contains all the instructional components of CMI, plus particulars related to the presentation of the information and to the conditions of learning.

4. LEARNING SYSTEMS

A- Description.

We refer here to simulation and dialogue type of applications. The student is not taught but is presented with a system with which he can interact. Of this interaction stems the learning.

B- Types.

4.1 INQUIRY AND DIALOGUE. Here the student uses the computer to get the information he wants, not according to a predecided sequence, but in relation to his present needs. It is a type of information retrieval with as little coding as possible for the student to perform. At one end, the student has to work with a small number of symbols to get the information. At the other, the student interacts freely with the computer in everyday language.

4.2 SIMULATION. In this type of use the program simulates a real situation (v.g. a patient being interviewed by a doctor; electronic circuitry, a satellite orbiting around the earth). By his actions the student brings a change in the system and is presented with the new situation.

C- Equipment.

The LEARNING SYSTEM type of application, in most cases, asks for a conversational system, slow terminal (teletype,cathode ray tube or plasma display panel), and little programming compared to the TEACHING SYSTEM type of application.

5. TOOL FOR RESEARCH.

We include in this category the application that help research in education, such as validating tests and courses, setting environment for research in psychology, experimenting learning models, etc...

CLASSIFICATION OF THE USES
OF COMPUTERS IN EDUCATION

1. LABORATORY TOOL
   - 1.1 CALCULATOR
   - 1.2 COMPILER
2. TEACHING SUPPORT SYSTEMS
   - 2.1 TEACHER ORIENTED
     - 2.1.1 DATA BANK
     - 2.1.2 ANSWER PROCESSOR
     - 2.1.3 STATISTICAL PACKAGE
     - 2.1.4 TEST GENERATOR
   - 2.2 STUDENT ORIENTED
     - 2.2.1 INDIVIDUAL TESTING
     - 2.2.2 COMPUTER MANAGED INSTRUCTION (C.M.I.)
3. TEACHING SYSTEMS
   - 3.1 C.A.I. - DRILL AND PRACTICE
   - 3.2 C.A.I. - TUTORIAL AND SOCRATIC
4. LEARNING SYSTEM
   - 4.1 INQUIRY AND DIALOGUE
   - 4.2 SIMULATION
5. TOOL FOR RESEARCH

FIGURE 11

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